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CONFIDENTIAL

MEASUREMENT OF THE VAPOR TENSION OVER SOLUTIONS OF He-3 IN He-4

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Certain results of studies of the properties of solutions of helium-3 in helium-4 were stated in previous works of the authors [1,2]. In these works the concentration of He-3 in the solutions was determined relative to the vapor tension over a mixture on the assumption that Raoult's law is correct. Since it is essential in these investigations that the concentration of He-3 be very exactly known, special experiments were set up to verify the applicability of this law, brief results of which will be given here. They employed the mixtures available to them with accurately known concentration of He-3 in the solutions. The vapor tension, or pressure, of He-3 was taken from the work [3].

The procedure followed in the measurements of the vapor tension and the apparatus employed for this purpose have already been described [4]. The difference in vapor tensions was measured over solutions and over pure He-4 by means of a differential oil manometer. In order to minimize the distortion due to the escape of part of He-3 into the gaseous phase, the apparatus was made small in size. The measurements of the vapor tension for each mixture were conducted over a wide temperature interval, and for each of the mixtures the dependence of vapor tension upon the quantity of liquid in the apparatus was investigated, which allowed one to judge the influence of He-3 passing into the gaseous phase. Results of these experiments showed that because of this too small quantities of the liquid give values of concentration which are low. With increasing quantities of the liquid the measured concentration also increases, finally reaching a constant value and not depending further upon the quantity of the liquid; within the accuracy of the measurements this value equals the original concentration. Using this data the authors were able to evaluate the quantity of liquid necessary for a correct measurement of the concentration of He-3, which in their apparatus turned out to equal 10 mm^3, for a concentration of He-3 of 0.7% and temperature of 1.4°K.

The results of measurements of the concentration of He-3 according to vapor tension , which were conducted for four mixtures at the temperature 1.4°K, are given below:

c_0 (%)	q (cm^2)	c_p (%)
0.15	39	0.15
0.38	6	0.3
0.98	7	0.7
1.89	5.5	1.4

Here c_0 is the concentration of He-3 in the mixture; c_p is the concentration determined according to vapor tension; and q is the quantity of the condensed mixture.

This data shows that c_0 and c_p agree when a sufficient quantity of the liquid was condensed in the apparatus. Otherwise the quantity of the condensed mixture was somewhat less than necessary, which led to the obtaining of low values for the concentration. If the results of the experiments on the determination of the dependence of vapor tension upon quantity of liquid are employed and the corresponding corrections are introduced, then these values lead to concentrations close to the original one.

Thus the experiments conducted permit one to make conclusions concerning the behavior of solutions of He-3 in He-4 close to the ideal, at least for concentrations of He-3 up to 2%. Raoult's law will probably be observed even for large concentrations of He-3, as is possible to conclude from measurements of vapor tension over a solution containing 25.5% He-3, where the deviation from Raoult's law is still not large [5].

In connection with this it is appropriate to note that in the works of some authors [6,7] there were indications that Raoult's law is not observed for these mixtures. The deviations from Raoult's law obtained by the authors of the present work bear a contradictory character which reflect rather the experimental errors than the peculiar properties of these solutions. A detailed report on experiments conducted will be published in the immediate future.

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